Coordination Mechanisms for Human-Robot Teams in Space

Completed Technology Project (2017 - 2021)

Project Introduction

A major challenge of coordination in space environments is that teams are often spatially separated and operate at different time scales. Currently, there are few infrastructures set up to effectively coordinate the interaction of such complex teams. Thus, the goal of my proposal is to fill this gap by implementing a distributed computational framework that will be used to support dialogue and coordination in human-robot teams operating in space environments. The framework is based on the concept of a Shared Mental Model (SMM), which is a distributed construct used in effective human teams to track various aspects of the team (e.g., role, spatial location, perspective, etc.) and the task (equipment, procedures, scenarios, etc.) to manage the interaction. My plan involves not only implementing the SMM framework, but also developing novel dialogue mechanisms that use the information from the framework to determine what to say, when to say it, and to whom to say it. Mechanisms to support proximate (local) interaction will utilize features of the shared perceptual context, include perspective-taking, multi-modal interaction (e.g., pointing + speech), and joint attention. Because the framework is shared among all artificial agents on the team, it is able to synchronize information from a variety of sources across space and time, allowing remote agents to benefit from these proximate mechanisms as well. The final part of my proposal involves the evaluation of the system. I plan to develop realistic scenarios that will allow us to explore a variety of team, task, and communication structures in order to test the benefit of my proposed approach. This project has the potential to be applied in the near-future to many of NASA's objectives that rely on coordinated teams. Some examples include: joint maintenance and repair, site preparation, scientific experimentation, future missions to Mars, and other tasks for which mixed-agent teams are needed. Overall, my proposed project would help to improve coordination and performance in human-robot teams, bringing us a step closer towards NASA's vision of the joint-exploration of space.

Anticipated Benefits

This project has the potential to be applied in the near-future to many of NASA's objectives that rely on coordinated teams. Some examples include: joint maintenance and repair, site preparation, scientific experimentation, future missions to Mars, and other tasks for which mixed-agent teams are needed. Overall, my proposed project would help to improve coordination and performance in human-robot teams, bringing us a step closer towards NASA's vision of the joint-exploration of space.

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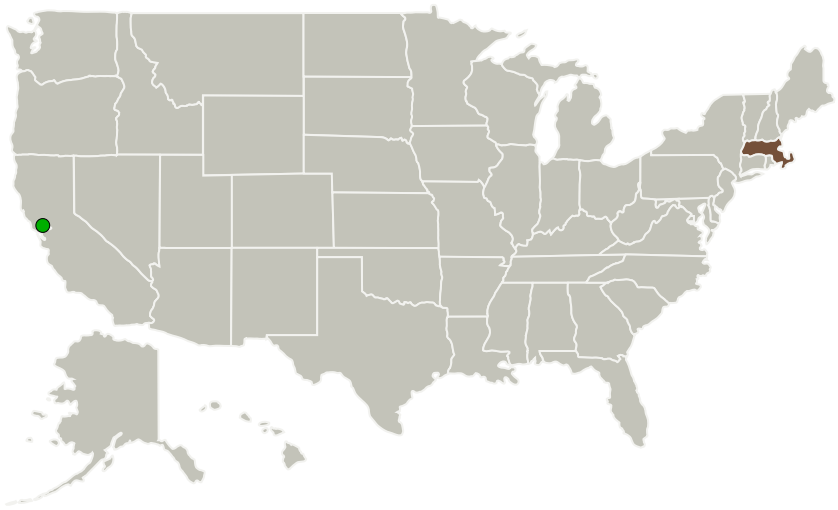
Table of Contents

Coordination Mechanisms for Human-Robot Teams in Space

Completed Technology Project (2017 - 2021)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Tufts University	Lead Organization	Academia	Medford, Massachusetts
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
Massachusetts

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Tufts University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Matthias Scheutz

Co-Investigator:

Felix Gervits

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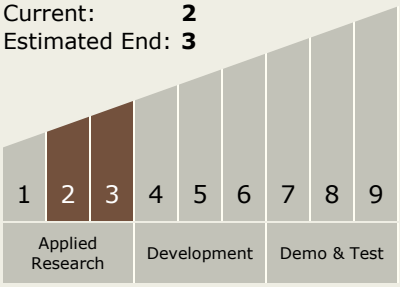
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.4 Human-Robot Interaction
    - TX04.4.2 Distributed Collaboration and Coordination

Target Destinations

Earth, The Moon, Mars